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THE WITMER FORMBOARD AND CYLINDERS AS TESTS FOR CHILDREN TWO TO SIX YEARS OF AGE

BY

GLADYS GENEVRA IDE

A THESIS

PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

PHILADELPHIA, PA.
THE PSYCHOLOGICAL CLINIC PRESS
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THE WITMER FORMBOARD AND CYLINDERS AS TESTS FOR CHILDREN TWO TO SIX YEARS OF AGE.[1]

By Gladys Genevra Ide,
University of Pennsylvania.

I. Introduction.

The Witmer formboard and cylinders have been used for several years in the Psychological Clinic of the University of Pennsylvania as a means for measuring the abilities of children. Since no one knew how the ordinary child performed the test nor in how many seconds he could do it, comparisons were always made between children of like age who had appeared at the Clinic. In 1915, Dr. Herman H. Young obtained formboard records from a large number of normal children of school age in the public schools of Philadelphia, and a similar investigation for the cylinders has recently been made by Dr. Franklin C. Paschal. Not enough records have yet been collected for the standardization of either test, but a start in that direction has been made.

Many children of less than six years are brought to the Clinic for examination. The use of either of these tests as testing or teaching material is of doubtful value if no one knows what is to be expected of normal children of from two to six years of age. The Clinic has held consistently that the child of four years should be able to do the formboard correctly, and the child of six years, the cylinders, but this view came as a result of clinical experience and not from the records of a large number of normal children. Through a study of records of normal children of kindergarten age or younger the present investigation aims to determine:

1. The age level of the tests;
2. Their clinical value;
3. The earliest passing age;
4. The analytic determination of the causes of failure; and
5. The value of their employment as a test of educability.

Young tested 32 five-year-old children with the formboard. Of this number 14 were boys and 18 were girls. Three boys were successful in the first trial and the remainder in the second trial,

[1] Reprinted from THE PSYCHOLOGICAL CLINIC, Vol. XII. No. 3, May 15, 1918.

while 3 girls were successful in the first trial, 14 in the second and 1 in the third. Of 28 four-year-old children tested, 9 of the ten boys required two trials for a successful performance, while the tenth boy required three trials. Four girls succeeded in the first trial, 11 in the second, and 3 in the third trial.

These figures would seem to indicate that four and five-year-old children are not able to do the formboard on the first trial, but in reality the number of failures to perform it at the first attempt is due to the limit of time which Young allowed. Since the Clinic made no restriction in time, none was placed on either of the tests used in this investigation.

II. Description.

The children chosen as subjects were from kindergartens connected with the public schools of Philadelphia, or those operated in conjunction with social centers. The American children came from families very few of whom were professional people, but who were well able to maintain their children. The foreign children came from homes in the foreign quarter. Most of them were from families financially well above the poverty line, but in a few cases the homes were being maintained by charitable organizations. Practically all nationalities were represented, but Americans and Jews predominate, while Italians, Poles, Austrians, and Roumanians other than Jews, French, Spanish, Germans, and Turks make up the completed list. In determining a child's nationality, he was considered as being of that nation to which his parents formerly belonged. If his parents were born in the United States, he was considered an American.

The nationality and age of the child were taken from the reports which the schools require of the parents. They were supplemented by the teacher's knowledge. In some cases the aid of social workers and the parish priest was sought in the attempt to determine the ages of children, and yet it seems fairly certain that some of the ages of the foreign children are not the true ones. Those for the American children may be presumed correct. Foreign parents wish their children to enter the industrial field as soon as possible. For this reason they enter their children at the kindergartens just as soon as the size of the child will enable them to swear to an age of four years. As a result, many are entered shortly after they have passed their third birthday. Again, many foreigners pay no attention to the date of a child's birth, or remember it in relation to some holiday, so that the birthday is unknown and is given as is convenient.

In the present study it was noted that the birthdays of a large number of children were given as occurring in August, September, or January, months in which the child would be entering school. In the Polish section of the city, the dates of birth were obtained from the parish priest who had made a record of the date of baptism as the date of birth. In one social center there was no record of any sort, the dates given being those of the teacher in charge who had been in the district when the children were born, and who gave the ages as nearly as she could remember.

The tests used were the Witmer formboard and cylinders. The formboard, including the raised edge on each side, is one foot square. The surrounding edge, three-quarters of an inch wide, fits flush with the back of the board and even with the tops of the blocks when they are in place. At one side, a tray three and one-quarter inches wide and half an inch deep, extends across the board. The remaining section of the board is divided into spaces suitable for the accommodation of eleven geometrical figures as nearly uniform in area as their variety of form will allow. The area is about 2.25 square inches and the thickness one-half inch. The recess in which the block is placed is just enough larger than the block to permit the piece to slide easily into place without danger of becoming wedged in by a vigorous subject. The depth of each recess is one-half that of the blocks, so that when placed the blocks extend one-fourth inch above the surface of the board. The blocks and their recesses are of such a size and shape that no block can be fitted into any recess other than its own. Both board and blocks are neatly stained, the board being light oak and the blocks walnut, while the recesses are painted black, thus affording an effective contrast between the board, blocks and recesses. The tray at the top of the board is a receptacle for the blocks when removed from their recesses. It determines definitely where the blocks are to be placed and insures that they shall be within the reach of the subject throughout the test. The blocks are numbered in consecutive order from one to eleven, number one being the square, two the rectangle, three the cross, four the ellipse, five the semicircle, six the circle, seven the isosceles triangle, eight the star, nine the equilateral triangle, ten the hexagon, and eleven the rhombus.

Each subject was tested individually. He was required to stand during the test directly in front of the board, which was placed on a chair or a low table with the tray farthest from him. The board was placed so that the light fell in such a way that no shadows obscured it. In some schools a private room was available, and in that case no one was present in the room but the subject and

experimenter. In other schools no private room was available and in those cases the subject was taken as far from the others as possible and screened from their view. The conditions were thus not ideal, but the children were less disturbed emotionally when the tests were given in the room with the others than when they were taken into strange surroundings with the associations which are built around a room used by the school dentist, doctor, or nurse. The tests were continued from November to May inclusive, thus securing all gradations of temperature and health. All the children of a given kindergarten were tested and the records retained except only those from colored children and from subjects with obviously defective sight.

The blocks were left in their proper recesses until the subject had placed himself before the board, when they were removed from the tray in a random order by the experimenter. At the same time the experimenter remarked, "I am going to take these blocks out and put them up here. I want to see how quickly you can put them back where they belong. You may use both hands and work as fast as you can." If the subject did not seem to understand—and many did not since they did not speak English—the experimenter added further, "You put them away," accompanying the words by a gesture from the tray toward the reccesses. No child failed to understand after the gesture.

The time—to the nearest second—required for the completion of the test was taken, as was also an observation as to method, and in the case of failure, the reason for failure. The watch was kept in the hand as much out of sight of the child as possible. The experimenter sat behind the child and slightly to one side, so that the board was clearly visible. This position was necessary since many kindergarten children depend largely on the affirmative or negative cues given by the teacher as a guide to their next act.

If the subject succeeded with the test the first time, he was not required to repeat it, but if he failed the first time, that is, failed to place all the blocks correctly in the spaces, not over them or leaning on the edge, by his own efforts, the blocks were correctly placed for him by the experimenter, no word being spoken, and then removed in a definite order, three piles being formed in the tray. The first pile contained blocks numbered five, ten, seven, and eight placed directly above recess number one; the second pile, placed between recess four and seven, included blocks numbered eleven, two, and nine, and the third pile, consisting of blocks numbered one, six, four, and three, was placed above recess nine. The numbering of the blocks was always from the topmost block downward. After

the blocks had been so placed, the experimenter said, "I want to see if you cannot put them in quicker this time." If the child failed to place the blocks correctly on this trial, he was permitted to remove them himself the third time, the directions given being, "This time you may take out the blocks yourself and put them in the tray, and then see if you can't put them in quicker." The subject removed the blocks as he saw fit, except that he was required to place them in the tray.

If the third trial proved a failure, the blocks not placed correctly were removed from the board, and the circle, the one most easily placed—was handed to the child, and he was told to put it away. If he did not succeed in placing it, he was told "Put it there," the experimenter pointing to the correct recess. When placed correctly the experimenter removed the block and offered it again with the same words as before. If the block was correctly placed a second one was offered, and so on until all the blocks had been correctly placed. If some of the blocks had been correctly placed in the first trials, this amount of teaching was sufficient to insure success in a succeeding trial, where the procedure was the same as in trial three.

If in the preceding trials, none of the blocks had been correctly placed, then all the blocks except the circle were correctly placed and this was offered to the child to place. No child failed to place the circle, although in the case of two-year-old subjects the experimenter moved the hand toward the recess so that the child would learn what was wanted of him, when he could not understand the words of direction. When one block was placed correctly, two spaces were left vacant, the blocks offered in different order, and the number of blocks was increased until five or six would be removed at once and all correctly replaced. Beyond this point it was unnecessary to go, as the children were then able to place all the blocks by themselves.

The second test, the cylinders, consists of a single solid frame of wood, formed of seven layers of pine, each three-eighths inch thick, and glued together in such fashion that alternate layers of the wood are grained at right angles. This frame is circular with a diameter of ten and a half inches. Six layers of the wood are removed from the center in such a way that an inner open circular space seven and a half inches in diameter and two and one-fourth inches in depth is formed. The outer wall varies from two and one-eighth inches at the widest point to one and one-sixteenth inches at the narrowest point to accommodate the different diameters of cylinders reposing in recesses cut in this outer wall. Eighteen recesses are cut in the

wall, the deepest being two and one-sixteenth inches, and when that recess is placed farthest from the observer a variation of three-sixteenths of an inch is made in each of seven recesses to the right of the deepest one, the shallowest recess thus formed being fifteen-sixteenths of an inch deep. The recesses to the left of the shallowest then increase in depth in the same degree until the maximum is again reached. The recesses are just large enough to receive easily cylinders of the following diameters; from the same post of observation, the cylinder filling the first space observed is two and one-sixteenth inches in diameter, its left-hand neighbor, one and eleven-sixteenth inches, and the succeeding cylinders respectively one and nine-sixteenths, one and five-sixteenths, one and one-sixteenth, and fifteen-sixteenth inches in diameter. From the observed point toward the right the same differences in diameter are noted until that of fifteen-sixteenths of an inch has been reached, after which all the remaining cylinders are of the same diameter, but of varying depth. The whole is finished in oil and varnish in the natural color of the wood.

In giving the test, the conditions and subject were the same as in the formboard test. The cylinders were placed before the subject with the largest cylinder at the point farthest from the child. The cylinders were removed from their recesses by the experimenter and placed in the center of the board. While doing this the experimenter observed, "I am going to put these blocks in the center (middle), and I want you to put them back where they belong. You may use one hand or both and work just as fast as you can." In this test, as well as with the formboard it was frequently necessary to add the more informal, "You put them away," accompanied by a gesture toward the recesses. The subject then tried to place the cylinders in the correct recesses. If he was successful the first time, he was dismissed, but if not, after the time and observations were taken as with the formboard, the cylinders incorrectly placed were removed and placed correctly and those not placed were placed. No word was spoken during the process. As soon as all the cylinders were placed, the whole procedure was repeated. If the subject succeeded the second time, no further attempt was made, but if he did not, a third trial was given in the same way. Teaching was not attempted in all cases of failure. In a few instances the test was taught to a child. When this was done, all the cylinders except two were placed. These two were handed to the subject and he placed them. The process was then repeated with three cylinders and then four and so on as the child became proficient. The drill was continued until all the cylinders of a given diameter but of varying depth had been

taught. Then those of varying diameter and the same depth were taught and then the remainder. Two cylinders could be used at the beginning because the children of four years had had enough previous experience with the tests to understand the first principles of putting the cylinder in its place. If an error was made while the child was learning, the cylinder was removed by the experimenter and offered again later. If the child again made an error, the correct recess was pointed out and the child told to "Put it there."

§1. Statistical Aspects of the Formboard—*Five-year-old Children.*

The formboard was used as a test with 449 five-year-old children. Of this number 231 were boys and 218 were girls. Table 1 shows the number of cases of failure and the percentage of failure for the year groups. The year groups include all children within two weeks of their fifth birthday and those within two weeks of their sixth birthday.

Table 1.—Number Failing on both Formboard and Cylinders.

Age	Number of Cases	Number Failing 1st Trial	Per Cent Failing 1st Trial	Number Failing on 2 Trials	Per Cent Failing on 2 Trials	Number Failing on 3 Trials	Per Cent Failing on 3 Trials
FORMBOARD.							
Boys.							
5	231	19	8.2	9	3.9	4	1.7
4	154	29	18.8	5	3.2	4	2.6
Girls.							
5	218	22	10.1	8	3.6	3	1.4
4	157	44	27.9	15	9.5	8	5.1
CYLINDERS.							
Boys.							
5	189	140	73.9	78	41.5	62	32.9
Girls.							
5	179	124	69.3	70	39.1	48	26.8

Nineteen or 8.2 per cent of the five-year boys failed to complete the formboard correctly the first trial, and 22 or 10.1 per cent of the girls. The first trial is taken as the significant trial to eliminate the learning process which is so large a factor in the second and third

trials. But 1.7 per cent of the boys and 1.4 per cent of the girls failed to complete the board successfully in three trials.

Seventy-nine of the boys were Americans and 82 were foreign-born Jews; 2.5 per cent of the American boys and 13.4 per cent of

TABLE 2.—COMPARISON OF RESULTS FROM AMERICANS AND JEWS OF FOREIGN PARENTAGE.

Age	Number of Cases	Number Failing 1st Trial	Per Cent Failing 1st Trial	Number Failing on 2 Trials	Per Cent Failing on 2 Trials	Number Failing on 3 Trials	Per Cent Failing on 3 Trials
FORMBOARD.							
AMERICAN BOYS.							
5	79	2	2.5	1	1.3	1	1.3
4	58	9	15.5	2	3.4	2	3.4
JEWISH BOYS.							
5	82	11	13.4	7	8.5	3	3.6
4	69	15	23.2	2	2.9	2	2.9
AMERICAN GIRLS.							
5	100	6	6	2	2	2	2
4	59	15	25.4	4	6.7	2	3.4
JEWISH GIRLS.							
5	63	9	14.3	2	3.1	1	1.6
4	63	19	30.2	7	11.1	4	6.3
CYLINDERS.							
AMERICAN BOYS.							
5	68	44	64.5	18	26.5	12	17.6
JEWISH BOYS.							
5	58	42	72.4	28	48.3	27	46.6
AMERICAN GIRLS.							
5	84	54	64.3	38	45.2	19	22.6
JEWISH GIRLS.							
5	50	33	66.6	21	42	14	28

the Jewish boys failed the first trial as shown in table 2. Of the girls, 100 were Americans and 63 Jews; 6 per cent of the American girls and 14.3 per cent of the Jewish girls failed to pass the first trial. One and three-tenths per cent of the American boys and 3.6

per cent of the Jewish boys failed in three trials; while 2 per cent of the American girls and 1.6 per cent of the Jewish girls failed to pass the test in three trials. The percentage of failures in the first trials for both boys and girls is unusually high for the foreign-born Jewish children, while the percentage of failures of those who had three trials is higher for the boys, but lower for the girls.

Table 3 shows the time values for the successful performance on the first trial in relation to the number of cases of different ages,

TABLE 3.—TIME VALUES FOR SUCCESSFUL PERFORMANCE ON FIRST TRIAL AND NUMBER OF CASES OF DIFFERENT AGES.

Age	No. of Cases	Mean	Mean Deviation	Minimum	Lowest Quintile	Lower Quintile	Median	Upper Quintile	Highest Quintile	Maximum
FORMBOARD.										
Boys										
5.75	130	1m 8.8s	25.5s	25s	45s	55s	1m	1m 5s	1m 30s	3m 42s
5.25	82	1m 13.6s	30.4s	25s	44s	55s	1m	1m 3s	1m 18s	5m 32s
4.75	86	1m 46.1s	49.2s	28s	53s	1m 10s	1m 26s	1m 39s	2m 13s	11m 15s
4.25	39	1m 41.5s	33.8s	38s	1m 1s	1m 21s	1m 37s	1m 41s	2m 11s	6m 10s
Girls.										
5.75	115	1m 6.9s	24.6s	27s	41s	53s	58s	1m 4s	1m 30s	2m 45s
5.25	81	1m 20.5s	36.3s	28s	45s	55s	1m 4s	1m 8s	1m 48s	5m 33s
4.75	68	1m 42.4s	53.4s	37s	55s	1m 5s	1m 13s	1m 24s	2m 10s	5m 43s
4.25	42	2m 25.3s	86.2s	37s	59s	1m 23s	1m 45s	2m 28s	3m 45s	9m 7s
CYLINDERS—ALL CASES.										
Boys.										
5.75	115			1m 28s	3m 5s	F	F	F	F	F
5.25	74			1m 23s	6m 15s	F	F	F	F	F
Girls.										
5.75	104			1m 4s	3m 26s	F	F	F	F	F
5.25	75			1m 55s	3m 7s	F	F	F	F	F

the age groups being divided into first and second half-years. The first column of the table indicates the ages, the second the number of cases of each age, the third the time values, in minutes and seconds, of the mean, and following it the mean deviation in seconds. The fifth column contains the minimum or shortest time record for the age, the sixth column the value of the record below which 20 per cent of the cases are distributed, the seventh column the value of that record below which 40 per cent of the cases are distributed, and the

eighth column, the median or the value above and below which 50 per cent of the cases are distributed. The ninth and tenth columns contain respectively values above which 40 per cent and 20 per cent of the cases are distributed, and the eleventh column contains the maximum or longest record made by an individual of the group.

Four and Three-year-old Children.

Three hundred and eleven four-year-old children, of whom 154 were boys and 157 were girls, were tested with the formboard. Of these, 29 or 18.8 per cent of the boys and 44 or 27.9 per cent of the girls failed to perform successfully the first trial; 2.6 per cent of the boys and 5.1 per cent of the girls did not succeed in three trials.

Fifty-eight of the boys were Americans and 69 were foreign-born Jews; 15.5 per cent of the American boys and 23.2 per cent of the Jewish boys failed on the first trial, while 3.4 per cent of the Americans and 2.9 per cent of the Jews failed in three trials. Fifty-nine of the girls were Americans and 63 Jews; 25.4 per cent of the American girls and 30.2 per cent of the Jewish girls failed in the first trial, while 3.4 per cent of the American girls and 6.3 per cent of the Jewish girls failed in the third trial.

The time values for the half year groups are shown in table 3 the same as for the five-year-olds. Except for the 4.25 year boys, the mean shows a decrease with an increase of age, with a lessened mean deviation. This tendency continues for the median and maximum as well as the other values shown in the table. The differences shown in the half-year groups clearly warrant norms for half year rather than for full year groups.

Sex differences are not clearly sustained. A larger percentage of both five and four-year-old girls fail on the first trial than of the boys, but the percentage of five-year-old girls failing in three trials is slightly less, and the percentage of four-year-old girls nearly twice as great as that of the boys. The percentage of both five and four-year-old girls of American parentage failing in the first trial is much greater than that of the boys, but the percentage of failure of American boys and girls for three trials is the same, while Jewish girls fail oftener than Jewish boys. Since the percentage of failure in the first trial of Jewish boys of either four or five is in excess of American boys of the same age, and the percentage of those failing in the third trial is very nearly the same, it seems doubtful whether the percental differences can be explained on the basis of either sex or nationality. The differences in time as shown in table 3 are not sufficiently consistent to warrant conclusions as to definite sex differences.

Thirteen boys and 15 girls of three years of age were given the

formboard test; 8 of the boys and 7 of the girls succeeded in performing the test on the first trial; 4 boys and 4 girls succeeded on the second trial, and 1 boy and 3 girls completed the test on the third trial. One girl failed to complete the test in the three trials. These children were all in the last half of the fourth year with the exception of one girl. The time required for the boys who completed the test on the first trial varied from 1 minute 10 seconds to 7 minutes 40 seconds and for the girls from 48 seconds to 4 minutes 27 seconds.

The shortest time required for a four-year-old American boy successfully to complete the formboard the first trial was 28 seconds. Two American girls and one Jewish girl each made a record of 37 seconds for the successful first trial. The best record for a five-year-old boy was 25 seconds and for a five-year-old girl was 27 seconds. Both of these children were Americans. In both cases the boys succeeded in a shorter time than did the girls. The situation is reversed in the case of the three-year-olds. An American girl of just three years completed the formboard in 48 seconds on the first trial, while an American boy of three and one-half years was successful in 70 seconds. A Jewish boy of 2 years 5 months succeeded with the formboard in 6 minutes 10 seconds on his first trial, and an American girl of 2 years 7 months in 1 minute 20 seconds.

Analytical Ratings.

Young, in his article entitled "Physical and Mental Factors Involved in the Formboard Test," has indicated a method of marking deficient performances upon an analytical chart on the basis of a five-point scale, where one is the rating given a subject who shows the least of any given trait or quality, and five the rating given when the greatest amount of the trait or quality is present. Three indicates the normal amount of whatever is being rated. If finer gradations are desired, each single group is divided into other groups of five points each. In Young's chart, he shows all of the mental elements which can be thus rated by an experimenter on observation of a subject during a test.

In the present experiment it was impossible to make complete ratings especially under the headings of physical adequacy or sensory fitness. No attempt was made to determine functional deficiencies, and only those with marked anatomical abnormalities were excluded. Except in cases of obvious myopia, no exclusions were made on the ground of sensory unfitness. Deafness was not considered a reason for exclusion where the child understood a gesture well enough to start work on the test, as he was as well fitted to be a subject as the child who did not speak English.

Ratings were made under the subdivisions of Vitality, Movement, Responsiveness, Attention, Imagination, and Memory, where these appeared to be factors in a failure. The attitude of the children, while of great importance, was not brought out sufficiently clearly to warrant a rating being made upon it. In a few instances, shyness was a factor in producing a refusal to attempt the test, but once attempted there was no evidence that it made a difference. Competitiveness did not affect the behavior of these children. None of them evinced any interest in what their fellows had done, and but one asked the time required for his performance.

The method of attack proved to be of value and was given a rating as to its kind, but not in relation to what older children do. In making the rating for each child, no attempt was made to fill out a complete chart. Grading was made only in the case of a performance above or below a certain level which the observer had noted by preliminary experimentation as the ordinary level for the child of this age. As this preliminary experimentation was necessarily somewhat limited, the ratings tend to be based largely upon the standard set by Young for his six-year-olds, and it is probable, therefore, that the grading made, especially in distribution of attention, is colored too much by the ratings made on six-year-old performances. When children of two and three years were tested, the standard for four years was used. This was obviously too high and it is likely that the ratings for these ages would better be made normal. However, as they are they serve the purpose for which they were made.

Each age-sex group were assumed to be a normal group, and under the five-point scale would be placed in group 3 in subdivision 3. Closer observation of each group reveals the fact that certain children have not performed as well as most of the other children of the group and some few have succeeded better than most of the group. In a few scattered instances, performances have been so much below that of the mass of the group that individuals have been placed in groups 4 and 5 rather than in 3.

Of the five-year-old boys, 182 have been placed in group 3. The time of their performance varied from 40 seconds to four minutes. Four boys were placed in group 1 because their performance was much shorter than that of their associates, and 21 were placed in group 2 as forming a class doing the formboard in less time than the rest of the group, but not so quickly as those in group 1. Groups 4 and 5 include the failures, the former those who succeeded in either the second or third trials, and the latter those who failed to successfully complete the board in the three trials.

One hundred and sixty-three five-year-old girls were rated in group 3, the time requirement being from 40 seconds to 3 minutes. Ten girls were placed in group 1, and 12 in group 2 because of their quickness of performance. Groups 4 and 5 contain the failures, the former containing 27 and the latter 4, the division of the groups being made on the same basis as that of the boys.

One hundred and one of the four-year-old boys and 91 of the girls were placed in group 3, 18 boys and 19 girls in group 2, and 10 boys and 7 girls in group 1; 23 boys and 39 girls were placed in group 4 because of failure to complete the formboard the first trial, and 8 each of boys and girls failed to complete the board success-

TABLE 4.—FAILURES AND SUCCESSES, DISTRIBUTED BY QUINTILES.

Age	No. of Cases	Group One	Time Range	Group Two	Time Range	Group Three	Time Range	Group Four		Group Five	
FORMBOARD.											
Boys.											
5	231	4	25s–30s	21	30s–40s	182	40s–4m	15	Failed	9	Failed
4	154	10	25s–45s	12	45s–55s	101	55s–13m	27	Failed	4	Failed
Girls.											
5	218	5	25s–30s	19	30s–40s	163	40s–3m	23	Failed	8	Failed
4	157	7	35s–45s	12	45s–55s	91	55s–6m	39	Failed	8	Failed
CYLINDERS.											
Boys.											
5	189	12	1m–2m	37	2m–4m	103	Failed	32	Failed	5	Failed
Girls.											
5	179	11	1m–2m	44	2m–4m	88	Failed	33	Failed	3	Failed

fully in three trials and were placed in group 5. Table 4 shows this distribution for both age and sex.

Of the failures of the five-year-old boys, two were rated 2–5 and 2–3 respectively in understanding of the test, and the remainder of the failures were judged to be due to absence of distribution of attention. Persistency of attention was rated at 3–1 in the case of one girl, and concentration of attention at 2–5 in the case of another. Distribution of attention was responsible for the remainder of the failures, as in the case of the boys.

The same ratio holds true for the four-year-olds. Imageability was rated at 2–5 in the case of one boy, and persistence of attention at 2–3 for another. Understanding was rated in group 2 four times as a factor in failures, and the remainder of the failures

were judged to be due to lack of distribution of attention. Understanding was rated once in group 2 and three times in group 1 as a factor in the failure of four-year-old girls, while concentration of attention was rated 2–2 once, and persistency of attention 2–3, 2–4, 2–5 in three different cases. As before, the lack of distribution of attention was the deciding factor in most of the cases of failure.

The failures among the three-year-olds were due to lack of distribution of attention in all cases except three. Two of these added to the lack of distribution of attention, poor persistency of attention. One failure was due to an absence of understanding of the test. The limited number of observations made upon three-year-old children makes it impossible to judge whether these failures are to be expected because the three-year-old child has not yet developed the necessary abilities for the correct performance of this test, or whether they are due to the specific absence of some ability in the individual. Although there is a wide range of individual difference in degree of maturity, it is assumed that the former is more nearly the case.

A number of children of two, three, and four years of age were unsuccessful in their first attempts with the formboard. These children were then taught how to complete the test. Analytical ratings were made as with the other children. A record of the number of trials for successful performance was kept, as well as a complete history of each didactic effort.

The Formboard as Didactic Material.

Girl, Jewish, aged 2 yrs. 3 mos.; 2 trials; teaching. Correct in 3 m. 25s.

Frieda had not yet lost the chubbiness of babyhood. She spoke no English but talked a little in Yiddish. She refused to reach for the blocks on the first trial, and they were handed to her, with a gesture toward the spaces. As soon as she moved her hand in the right direction no further help was given. In the first trial the blocks were all placed in spaces or over them, none correctly, with several grouped around No. 6. There was an absence of distribution of attention and the method used was purely trial and error. Blocks Nos. 6 and 2 were used to teach her how to place them. As soon as she would place these two, Nos. 1 and 10 were added. The process occupied three minutes. She was then given another trial. She reached for the blocks herself, using either hand but not both at the same time, and completed the board correctly in 3m. 25s. She then removed the blocks herself and replaced them correctly. The method used was better than trial and error. If a block did not fit in the recess in which she tried it, she placed it

back in the tray and selected another block for the same space. This method increased the time required for the performance but was successful in the long run. It enabled the child to complete the test with no change in the distribution of her attention.

Girl, Jewish, aged 2 yrs. 9 mos.; 4 trials; teaching. Correct in 1m. 45s.

Dottie placed all the blocks over spaces in 4m. 38s. No. 9 was over the correct space with No. 8 on top of it. She tried the star over the correct space, but did not succeed in getting it in. Distribution of attention was rated 2–1. The second trial resulted in five correctly placed blocks in 2m. 8s. Distribution of attention and understanding of the test were graded respectively 2–4 and 3–1. The third trial she placed three blocks correctly in 1m. 55s. She was taught with the blocks which she had not correctly placed. She then placed all the blocks correctly in 1m. 47s. After this she voluntarily performed the test five times, each time correctly. A block was replaced in the tray if it did not fit the first space in which it was tried, and the second block chosen was not always tried in the same space. The rating made in distribution of attention was not changed in the last trials.

Girl, Jewish, aged 3 yrs.; 4 trials; no teaching. Correct in 1m. 15s.

Elizabeth placed the blocks over spaces, none correctly, in 65s. Distribution of attention was rated 1–3 and understanding 2–3. On the second trial, seven blocks were correctly placed in 1m. 36s. The distribution of attention for this trial was graded 2–1. Five blocks were not correctly placed in the third trial which requred 6 minutes, but blocks were both removed from spaces and replaced. The fourth trial resulted in a successful performance in 1m. 15s. with no teaching.

Girl, Jewish, aged 3 yrs.; 6 trials; teaching. Correct in 2m. 25s

Rose placed the blocks over the spaces in 3 minutes. None were correct. She was rated 1–5 in interest and 2–1 in distribution of attention. After teaching with all the blocks, she again failed to place any of them, although she played with them for five minutes. She had constantly to be urged to place the blocks, and was rated 1–3 in persistence of attention. After teaching with all the blocks, she placed 6 blocks correctly in 3m. 2s. With the blocks not placed correctly she was taught. After this a third trial resulted in 6 correctly placed blocks in 2m. 17s. She was taught with the blocks not placed and a fourth trial given. Again 6 blocks were placed in 6m. 5s. The same blocks were not placed for each of these trials although the same number of blocks happened to be placed correctly. In the fifth trial, Rose for the first time removed a

block incorrectly placed. She still showed the same lack of persistence and distribution of attention. With no further teaching a sixth trial was given. She completed the test successfully in 2m. 25s. Blocks for particular recesses were chosen from the tray and she removed a wrongly placed block, replacing it correctly.

Girl, Italian, aged 4 yrs. 3 mos.; four trials; teaching. Correct in 2m. 45s.

Susie placed one block correctly in five minutes. She used the trial and error method. Persistence of attention was rated at 2–1 and distribution of attention at 2–5. Four blocks were correctly placed in 3m. 19s. Constant urging was necessary to get her to finish, and even then she made no attempt to place the blocks in spaces, but placed them over the spaces. After 3m. 44s. she placed 3 blocks successfully on the third trial. She was then taught with the blocks not placed. In 2m. 45s., she then completed the test successfully. She still required urging to make her work at all and the rating in persistence of attention was not raised in the last three trials. There was no lack of understanding of the test.

Boy, Jewish, aged 2 yrs. 4 mos.; 6 trials; teaching. Correct in 3m.

Benjamin placed Nos. 3 and 6 in 3m. 20s. He was rated 3–1 in coördination and 2–5 in observation and distribution of attention. A second trial resulted in 4 correctly placed blocks in 65s. and a third trial 3 correctly placed blocks in 2m. 10s. In both cases the distribution of attention was rated 2–5. Benjamin was then taught. He placed 7 blocks correctly in 1m. 30s. on his fourth trial. The method was improved in this trial. Closer observation of the blocks was made and they were rejected at once if they did not fit the space in which they were first tried. After teaching, 9 blocks were correctly placed in 1m. 5s. After teaching with the blocks not correctly placed, the board was completed successfully in 3 minutes. The increase in time in this trial appeared to be due to fatigue as the child held securely to the side of the chair with one hand, moved slowly and yawned frequently, but kept at work until it was finished.

Boy, Italian, aged 2 yrs. 6 mos.; 3 trials; teaching. Complete in 2 m. 20s.

Richard placed one block correctly in one minute in his initial effort with the formboard. It was necessary to hand the blocks to him to get him started to work. He placed the blocks in an orderly line but did not associate them with the spaces in the board. He was taught with all the blocks. The second trial he placed 3 blocks correctly in 1m. 4s., removing one incorrect one and placing the correct one over the space. With the blocks which he had not placed he was taught, and on a third trial completed the board correctly

in 2m. 20s. The rating for distribution of attention in all the trials was 2–2. The rating for understanding in the first two trials was 2–3.

Boy, Jewish, aged 2 yrs. 10 mos.; 6 trials; teaching. Correct in 2m.

Lewis placed one block correctly in 3 minutes. His rating for understanding was 2–1 and for distribution of attention was 2–3. After being taught with all the blocks, one block was correctly placed at the end of 2 minutes. His movements were erratic and the rating in understanding and distribution of attention was not increased in this trial. After all the blocks were again used in teaching, 3 blocks were correctly placed in 2m. 3s., showing an adequate amount of persistence of attention but no better distribution of attention. After teaching, all the blocks were placed in the wrong spaces in 2m. 31s. During this trial there was evidence of fatigue and he was dismissed for the day. On the following day at the same hour he completed the test with one suggestion in 3m. 4s., pushing hard at the blocks and grunting happily when he had got them into place. The suggestion was made in the case of No. 9 which he could not place even after he had chosen the correct space. The final trial was successful in 2m.

Boy, Jewish, aged 3 yrs. 2 mos.; 4 trials; teaching. Correct in 3m. 31s.

Harry failed to place any of the blocks in 1m. 20s. Distribution of attention and understanding were graded 2–1. After teaching with all the blocks, he still failed to place any correctly in 3m. 30s. He made great efforts to push the blocks into the wrong spaces. After further teaching with all the blocks, he placed 8 correctly in 2m. 20s. Those wrongly placed were again used as teaching material, following which he successfully placed all the blocks in 3m. 31s.

Boy, Jewish, aged 4 yrs. 8 mos.; 5 trials; teaching. Correct in 54s.

Aleck placed four blocks correctly in his first trial with the formboard. He was rated 2–3 in observation and 4–3 in rate of movement. The ratings were not changed in the second trial when he placed 7 blocks correctly in 2m. 6s. Six blocks were correctly placed in 1m. 48s. on the third trial, in which observation was rated 2–5. He removed correctly placed blocks and tried to replace them with blocks very different from those removed. In the fourth trial he placed 9 blocks correctly in 1m. 42s. He was then taught with the blocks which had not been correctly placed, and completed the board in 54s. Exactly one week later he performed the test in 76s. with no errors. A final rating of 2–3 in observation in direct comparison with four-year-old boys was made in his case.

Conclusions.

Ninety per cent of five-year-old children should be expected successfully to complete the formboard on the first trial, according to the results obtained in this investigation. Two per cent may be expected to fail to complete it in three trials. Seventy-five per cent of four-year-old children should be successful in the first trial, while 5 per cent may not be able to complete the test in three trials. Although the number of cases is very small, it seems that half of the three-year-old children in the last half of the year may be expected to be successful in the first trial, while many of the remainder will succeed after several trials, or may be taught in a short time. This is also true of younger children.

Five-year-old children possess adequate distribution of attention to be successful with the test. Understanding of the test, persistence of attention and other abilities may occasionally be lacking, but are not conspicuously absent in children of this age. Four-year-old children show less distribution of attention than the five-year-olds, and this ability decreases with age. Among the two-year-olds tried with the test, none showed adequate distribution of attention for success with a method other than trial and error or fitting a given space with blocks chosen at random. Fitting the block to a space was a method which appeared with greater distribution of attention, and was used by the five-year-olds and most of the four-year-olds.

The rate of movement was slow with the smaller children and increased with age, as the shortened time for successful performances indicates. Only one child tried to hurry when told to do so. Two four-year-olds and 20 five-year-olds used both hands in placing the blocks. Either hand, but not both, was used by the younger children.

Several of the small children sang lustily while working. All pushed hard at the blocks to get them in the spaces, and all gave the blocks a pat with the palm of the hand after they were in. Often this was accompanied by a grunt of satisfaction. Once at work they paid no attention to the experimenter. At no time was there evidence of ill temper while the board was being used. There were a few occasions when a child had to be left to himself in the room while another child performed the test in order that he might acquire confidence to approach the board. If the child would not approach the board of his own accord, he was left for another time. Only one failure was recorded because of refusal to come to the board, and this was not counted with the others, as the child had just been removed from her own home to a temporary home.

From these results we may conclude:—

1. The age level for the formboard is four years;

2. It has clinical value analytically for children of four and five years of age, and probably of those of three years.

3. The passing age level is the last half of the fourth year.

4. The most frequent cause of failure is the absence of sufficient distribution of attention which seems to be a function of age; and

5. Failing as clinical material, the formboard may profitably be used didactically for purposes of analysis and for observation of the learning process.

§2. The Witmer Cylinders.

Of the 368 five-year-old children who were given the cylinder test, 189 were boys and 179 were girls; 140 or 73.9 per cent of the boys and 124 or 63.9 per cent of the girls failed to perform the test successfully on the first trial, (table 1); 41.5 per cent of the boys and 39.1 per cent of the girls failed on the second trial and 32.9 per cent of the boys and 26.8 per cent of the girls failed on the third trial.

Table 2 shows the percentage of Jewish boys as opposed to American boys and Jewish girls as opposed to American girls. As was the case with the formboard, the percentage of failures among the Jewish boys is considerably in excess of that of the American boys, while the differences in the case of the girls is very much less marked.

Of the boys of 5.75 years 33 were successful on the first trial with an average time of 3m. 21.5s. The mean deviation was 2m. 27.2s. Sixteen boys of 5.25 years were successful on the first trial, with an average time of 3m. 9.4s. The mean deviation was 1m. 17.1s. Thirty-two girls of 5.75 yrs. were successful on the first trial with an average time of 3m. 12.4s. The mean deviation was 1m. 19.2s. Twenty-three girls of 5.25 years were successful the first trial; their average time was 3m. 20.2s. with a mean deviation of 1m. 6.3s.

Distribution of the results of the cylinder test by quintiles showed that the normal group or group 3 contained only those who had failed the first time. It included also some who had failed on the second trial, but whose errors on this trial were few in number and not gross in character; 103 boys and 88 girls were placed in this group. Thirty-two boys and 33 girls were placed in group four. They did not succeed in completing the test in three trials, but their results showed a decreasing number of errors and indicated that they were learning. Five boys and 3 girls were placed in group 5 not only because they failed in three trials to complete the test, but also because an increased number of errors in each trial showed

that they were not learning. Groups 1 and 2 include those successful on the first trial, (table 4).

Table 3 shows the time distribution as far as possible and the distribution by quintiles in even groups. Only the figures for the lowest quintile or the lowest 20 per cent can be given, as all the other groups contain only failures. The mean and mean deviation for the successes of the entire group regardless of the number of trials are meaningless, as many of those who failed on the first or second trial learned enough during those trials to perform successfully in less time than was required by those who were successful on the first trial.

The same children who did the cylinders also did the formboard. By the Spearman rank method, using time as the basis of ranking, except for the unsuccessful third trials where the number of final errors was used, the correlation between the two series was .2065 for the boys and .1492 for the girls. This low correlation between two tests of apparently such similar character agrees with the results obtained by Mrs. Mary Hoover Young with the same tests.

Eleven four-year-old boys and 9 four-year-old girls were given the cylinder test. They were chosen as being the best of the group from the standpoint of their performance on the formboard—an assumption not warranted by subsequent correlation coefficients—in conjunction with the teacher's opinion of their kindergarten work; 5 of the boys succeeded the first trial, 2 the third trial, and 4 failed in the three trials. Three of the girls succeeded the first trial, 2 the second trial and 1 the third trial, while 3 failed in all three trials.

The shortest time required for an American boy to perform the cylinder test for the first trial was 1m. 23s. A Jewish girl gave the same performance in 1m. 4s. Both of these children were five years of age. A Polish girl of four years, six months performed the test in 1m. 10s. the first trial. A Jewish boy of four years eight months completed the test in 1m. 58s. No children younger than four years were tried with the cylinders.

The Cylinders as Didactic Material.

Boy, Italian, aged 4 yrs.; 8 trials; teaching. Complete in 1m. 42s.

Pasquale completed the formboard correctly and then placed 3 cylinders in 4m. 59s. His analytic and distributive attention were rated 2–3. He was persistent, but in a nervous excited sort of way. He placed 3 cylinders correctly in 3m. 50s. on the second trial and 4 correctly in 4m. 8s. on the trial. He showed the same lack of

distribution of attention and analytic concentration that he had on the first trial. He was then taught with all the cylinders. The fourth trial resulted in 3 correctly placed cylinders in eight minutes. At this time Pasquale was dismissed and was not recalled to the task until two days later, when he placed 11 cylinders correctly in 3m. 50s. The errors consisted of interchanges of cylinders of small difference in height. The distributive attention had improved and was rated at 3–1, and the analytic concentration of attention was rated at 2–5, while there was much less of the hurried nervous movement noted the first day. After 2m. 1s., 10 cylinders were correctly placed on the sixth trial, and 12 were correctly placed after 2m. 21s. on the seventh trial. Teaching with the incorrectly placed blocks was continued and an eighth trial then given. After 1m. 42s. two cylinders were left interchanged. This was corrected on one suggestion. Two subsequent trials undertaken on his own initiative were successful.

Boy, Jewish, aged 4 yrs.; 8 trials; teaching. Complete in 2m. 11s.

Sam placed one cylinder correctly on his first attempt. He was rated 3–1 both in distribution and concentration of attention. He talked constantly to himself and suggested that some of the tops of the cylinders ought to be chopped off. He did not remove a cylinder after having once placed it. He was rated 2–4 in general understanding of the test, the grade being the same for the first three trials. The second trial resulted in 7 cylinders being correctly placed in 14m. 20s. The distribution of attention was rated at 3–1. During the third trial, when he placed 12 cylinders correctly in 7m., his attention was easily distracted, and he was rated 2–3 in persistent concentration of attention. Teaching followed this trial, and then the boy was dismissed for the day. One week later at the same time a fifth trial resulted in 3 cylinders successfully placed in 2m. 5s. Understanding of the test was rated 2–5 in this trial. Persistent concentration of attention was good. The sixth trial resulted in 8 errors at the end of 6 minutes, with many deep sighs from the subject. There was no evidence of illness, but some urging was necessary to induce him to complete the test. The seventh trial resulted in 2 errors, both interchanges of cylinders of the same diameter but of different length, after 3m. 5s. They were corrected with one suggestion. The eighth trial was successful in 2m. 11s., using the method of fitting the cylinder to the recess.

Boy, Jewish, aged 4 yrs.; 4 trials; no teaching. Complete in 5m. 46s.

Max placed 5 cylinders correctly in 5m. 47s., leaving 2 cylinders

unplaced. On a second trial he placed 13 cylinders correctly in 4m. 31s. He was dismissed without teaching, and two days later at the same hour was recalled to complete the test successfully in 5m. 46s. The method was trial and error. The failure the first day was due to lack of understanding, in which he was rated 2–5.

Boy, Jewish, aged 4 yrs. 5 mos.; 4 trials; teaching. Complete in 1m. 31s.

Bernard placed 9 cylinders correctly in 5 minutes. One was left unplaced. He fitted the cylinders to the spaces. Distributive attention was rated 2–5. Those cylinders placed in too shallow a recess he attempted to push in by violence, even suggesting the use of a hammer. The second trial showed a better distribution of attention, although but 5 cylinders were correctly placed in 3m. 29s. Five cylinders were correctly placed and one left unplaced in the third trial in 2m. 9s. The errors were always among cylinders of the same diameter but of different length. Correctly placed cylinders were removed and placed in spaces not intended for them, thus showing an absence of understanding of the test. Teaching followed this trial and then Max had a glass of milk and a cake. The trial following the refreshment was successful in 1m. 35s.

Boy, Jewish, aged 4 yrs.; 4 trials; teaching. Correct in 2m. 20s.

Teddy placed no blocks correctly on the first trial of the cylinders, which required 6m. 20s. He constantly remarked that he could not do it, and applied opprobrious street terms to cylinders which would not enter spaces in which he tried to force them. He was rated 1–5 in persistence of attention and 2–3 in interest. He knew what he was supposed to do, but had no intention of doing it if he could get out of it. He placed 9 cylinders correctly in 6m. 2s. on his second attempt. He still required urging to get him to work. His third trial, completed at the end of 3m. 7s., resulted in but three misplaced cylinders and his reactions to the test appeared normal. He remarked that he knew he could do it on the fourth trial, and was successful in 2m. 20s. No formal teaching was given in this case, but without the stimuli supplied during the first two trials the test would never have been completed successfully.

Boy, American, aged 4 yrs. 11 mos.; 5 trials; teaching. Correct in 2m. 25s.

Seven errors were left on the first attempt Hamilton made to complete the cylinder test. The time was 4m. 48s. He removed blocks correctly placed, but replaced all but one of them. His understanding of the test was rated 3–1 and his distribution of attention 2–5. Six cylinders were correctly placed on the second trial, completed in 4m. 55s. One cylinder was not placed. Analytic

concentration of attention was rated 2–4 for this performance. Only 6 cylinders were correct after 4m. 16s. on the third trial. Teaching followed, and for a third time 6 cylinders were correctly placed in 2m. 25s. On two suggestions these were corrected and the test completed in 4m. 15s. The fifth trial was successful in 3m. 12s.

Boy, Irish-American, aged 5 yrs. 5 mos.; 3 trials; teaching. Complete in 2m. 1s.

William was reported very dull by his teacher. He placed 12 cylinders correctly in 2m. 13s. on his first attempt. His errors were interchanges of cylinders varying in diameter. His rating on observation was 3–1. Using the trial and error method he placed 6 cylinders correctly in 9m. 2s. the second trial. He removed correctly placed cylinders, replacing them by cylinders very different. His rate of movement was very slow, rated at 1–5, and his understanding of the test 2–3. Finally he placed all the blocks but the largest one, which he omitted, replacing it by its right hand neighbor and continuing the process half-way around the board so that a large number of errors resulted. He could not find out what was wrong, so he was told where to place the largest cylinder, after which he readily placed the others correctly. The third trial was successfully completed in 2m. 1s.

Girl, Jewish, aged 4 yrs. 10 mos.; 5 trials; no teaching. Complete in 4m. 2s.

Miriam succeeded easily with the formboard, but placed only 3 cylinders correctly in 4m. 8s. She removed cylinders which did not satisfy her and pushed hard at those which rose too far above the surface of the board. She was rated 2–3 both in distributive attention and understanding of the test. On a second trial, 9 cylinders were placed correctly in 2m. 40s. She fitted the space with the cylinder and made her errors with cylinders of either the same diameter or height. The distribution of attention was rated 3–1. The third trial resulted in 12 correctly placed cylinders in 3m. 38s. Observation of differences was made only for diameters, any height being accepted for a space so long as the diameter was correct. There was no teaching at the end of this trial, as the performance seemed to warrant the assumption that she would get it herself. Twelve cylinders were correctly placed on the fourth trial in 6m. 15s. At the end of this trial Miriam remarked that the long one "showed out," indicating that she was beginning to understand what was wanted. On the fifth trial there were no errors, the cylinders being placed after 4m. 20s., the problem being attacked with an assurance wholly lacking in the first four trials.

Girl, American, aged 5 yrs. 6 mos.; 5 trials; teaching. Complete in 3m. 8s.

Helen, after 4m. 55s., completed a performance in which she had placed 12 cylinders correctly. She placed the blocks at random and did not remove them. Her rating in understanding was 2–1. Eleven cylinders were correctly placed in the second attempt after 1m. 27s., and 3 were correctly placed the third trial after 3m. 21s. The same lack of understanding was shown in these two trials and the rating for understanding remained the same. Teaching followed the third trial. Twelve cylinders were correctly placed in the fourth trial after 4m. 2s. These errors were corrected on one suggestion. The fifth trial was successful in 3m. 8s.

Conclusions.

The repeated low ratings for understanding given in the cases which were taught, indicate that the cylinder test is distinctly above the understanding of children of four years, and the fact that so many children of five years fail with the test confirms this view with children of five years. The results show:—

1. The age level of the test is certainly no lower than five years, and is more properly placed above five years;

2. The test is of value analytically for children of five years, but requires in the majority of cases too much time for its successful use to make it of general value as clinical material for children of four and five years;

3. The passing age level of 50 per cent of the group for one trial is certainly higher than five years;

4. The most common cause of failure is an inadequate understanding of the test as a result of its too great complexity; and

5. Failing as clinical material for children of five years, it still possesses value as didactic material where time does not limit the observation.

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